A.D. 1850 . . . . . N° 13,057.

SPECIFICATION

OF

ANTOINE PAUWELS
AND
VINCENT DUBOCHET.

MANUFACTURE OF COKE AND GAS, &c.

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Manufacture of Coke and Gas, &c.

PAUWELS AND DUBOCHET'S SPECIFICATION.

TO ALL TO WHOM THESE PRESENTS SHALL COME, we, ANTOINE PAUWELS, of Paris, in the Republic of France, Merchant, and VINCENT DUBOCHET, of Paris, in the Republic of France, Merchant, send greeting.

WHEREAS Her present most Excellent Majesty Queen Victoria, by Her Royal Letters Patent under the Great Seal of Great Britain, bearing date at Westminster, the Twenty-third day of April, in the thirteenth year of Her reign, did, for Herself, Her heirs and successors, give and grant unto us, the said Antoine Pauwels and Vincent Dubochet, Her especial license, full power, sole privilege and authority, that we, the said Antoine Pauwels and Vincent Dubochet, our exors, admors, and assigns, and such others as we, the said Antoine Pauwels and Vincent Dubochet, our exors, admors, or assigns, should at any time agree with, and no others, from time to time and at all times during the term of years therein mentioned, should and lawfully might make, use, exercise, and vend, within England, Wales, and the Town of Berwick-upon-Tweed, our Invention of "CERTAIN IMPROVEMENTS IN THE PRODUCTION OF COKE, AND OF GAS FOR ILLUMINATION, AND ALSO IN REGULATING THE CIRCULATION OF SUCH GAS;" in which said Letters Patent is contained a proviso, obliging us, the said Antoine Pauwels and Vincent Dubochet, by an instrument in writing under our hands and seals, or under the hand and seal of one of us, particularly to describe and ascertain the nature of our said Invention, and in what manner the same is to be performed, and to cause the same to be enrolled in Her Majesty's High Court of Chancery within six calendar months next and immediately after the date of the said in part recited Letters Patent, as in and by the same, reference being thereunto had, will more fully and at large appear.

Pauwels & Dubochet's Improvements in the Production of Coke and Gas.

NOW KNOW YE, that in compliance with the said proviso, we, the said Antoine Pauwels and Vincent Dubochet, do hereby declare that the nature of our said Invention, and the manner in which the same is to be performed, is particularly described and ascertained in and by the following description thereof, reference being had to the Drawings hereunto annexed, and to the letters and figures marked thereon (that is to say) :—

Before proceeding to the description of our Invention, we would observe that coke for the smelting of metals and the generation of steam in locomotives, has hitherto been obtained by the carbonization of pit coal, in ovens specially constructed for that purpose. This method of producing coke usually entails the loss of all the gaseous products, and many attempts have been made to obtain in their natural state the gaseous products generated in ordinary coke ovens, by protecting the gases from the action of the fire, but no oven has yet been devised capable of practically effecting the desired object, the apparatus hitherto employed being either incomplete or insufficient for the purpose. It has also hitherto been found practically impossible to protect the interior of the ovens from the pressure of the atmosphere, and the gas circulating in the flues or passages under the bed of the furnace being submitted either to excessive or insufficient pressure, according to the difference in the levels and other well-known circumstances, a loss of gas has been occasioned which it is important to prevent.

The present Invention has for its object, first, to extract from pit coal a gas fit for illumination, and to produce at the same time a quality of coke possessing all the properties requisite for smelting metals, and generating steam in locomotives; second, to regulate according to circumstances the pressure of the gas in the passages, so as to render the loss of gas as small as possible. These various results are obtained by means of two distinct apparatus, (viz^{t}) first, a pyrotechnic apparatus with its extractor, and second, a moderator. The pyrotechnic apparatus is constructed of bricks and cast and wrought iron; it is furnished with fireplaces for producing the necessary heat, by the combustion of coal, coke or other combustible, and has various flues for the circulation of the heat, with a peculiarly constructed heat magazine; and lastly, is furnished with divers apparatus, some serving as conductors for the gaseous products, and the others serving either permanently or at intervals to isolate the distilling apparatus, properly so called, from the others.

The complete apparatus, as shewn in Figure 1, Sheet I., in front and plan views, presents the aspect of a rectangular cube having an empty space in its centre, the capacity of which occupies about one-fifth of the whole apparatus. We do not however confine ourselves to these proportions, although we

consider them to be those by which the best results will be obtained. Beneath this space, which represents an oven, are placed fireplaces from which the caloric circulates to various parts of the apparatus, combined and arranged as hereafter described and shewn in the Drawings. The oven has two openings opposite to each other for feeding the coal into the oven and drawing out the coke; one opening would however answer the purpose. At the upper part of the dome is a chimney, G, for drawing off the gas and for the carbonization of the coal; it is furnished with valves, pipes, and other accessaries, the whole being arranged in the manner hereafter described, and as represented in Sheet I. of the accompanying Drawings in Figs. 1 to 7. The fireplaces or furnaces are shewn at A, A, below which are flues C, by means of which and of the registers P, P, P, P, the caloric produced in the fireplaces A, A, is caused to circulate at pleasure, either under the ovens in operation or directly towards the large exit chimney; C^1 are orifices for cleaning the flues C. Above the fireplace A is the bed D of the oven (made of firebrick), from this bed rises a wall (made by preference of an elliptical form), from the top of which springs the arch or dome E; these together form the oven.

In Figs. 2, 3, and 6, F, F, are the two opposite openings for feeding in the coal and discharging the coke, these openings are provided with moveable sliding doors; the coal might, however, be fed in through the opening or chimney G (Figs. 6 and 7), by means of tilt carts running on a railway above the ovens, or in any other manner suited to the locality. In the centre of the dome E is the lower end of the chimney G, which is made of firebrick and is enclosed in a cast-iron pipe H (Figures 6 and 7); at the top of this pipe is another, also of cast iron, having three openings I, I, I; the largest of these, which is furnished with a stopper or cover and is intended to facilitate the cleansing of the two pipes J, J, which lead to the hydraulic valves K, K (for which slide valves might be substituted), communicating with the pipe S, for extracting the gas; this pipe communicates with the regulator of the extractor. The upper orifice of the chimney G is arranged in such manner that it may be closed by means of a stopper or cover L (Fig. 1), during the process of distillation, or it may be furnished with a pipe M (Fig. 7), during the process of carbonization, as will be presently described. This pipe M is intended to put the chimney G in communication with the vertical pipe N and the horizontal flue O, and by means of the registers P^1 and P with the flues underneath the bed of the oven, so as to conduct the combustible gases at pleasure towards one or more of the ovens where heat is required to be directed, and finally by the register B^1 to the exit chimney B. It will be seen, on referring to Fig. 6, that the top of the chimney G is furnished with two

gas pipes J, J, having hydraulic valves K, and their pipes S. By means of this arrangement, in duplicate, if a double extractor were employed, continuous operation might be ensured, in case one of the extractors should momentarily cease to work. Q, Q, Q, represents the solid portions of the oven, composed of incombustible materials, such as bricks and sand, resting on the dome E, and surrounded on all sides by brickwork, and serving as a reservoir for caloric. T, T, Fig. 2, are small openings or passages to facilitate cleaning and to allow of the air entering under the bed of the ovens in order to effect the combustion of the gases. U, U, are air holes in the doors F, F, F.

The Extractor.

The object of this is to protect the pyrotechnic apparatus from atmospheric pressure. It is divided into three distinct parts. The first is composed of three vats full of water, in which three bells or moveable chambers are caused to work up and down by any convenient motive power made to act upon suitable shafts and cranks. The second part of the apparatus consists of two large cylinders, provided with rectangular plungers, united together and acting as valves, which constitute, with the first part of the mechanism, an aspirating and forcing apparatus, the action of which is regulated by the third portion of the apparatus, which consists of a large vat in which a bell or moveable chamber something like a gasometer works. The office of this latter is to regulate and maintain the equilibrium of the pressure.

This apparatus is represented in Sheet II. of the accompanying Drawings. Figures 8 and 9 represent a general plan view with sections taken at various elevations. Fig. 10 is a longitudinal section, taken at three different places, of the vats with their bells or moveable chambers, and the mechanism for actuating the same. Figure 11 is a transverse section of the vats, bells, or chambers, cylinders, and plungers. Fig. 12 is a section of the apparatus which serves to regulate and maintain the equilibrium of the pressure.

The vats A, A, A, being filled with water or any other liquid, each of the bells or chambers A^1, A^1, A^1, is successively put in motion in a vertical direction by means of the mechanism shewn at Fig. 10. During this movement the gas coming from the distilling apparatus through the pipe S (see Figs. 9 and 11) enters the cylinders G through the vertical pipe D, D, D, (Figures 9 and 11); the same bell or chamber descending forces the gas through the pipe F, and then down the descending pipe G^1 into the body of the cylinder H, from which the gas is driven through the pipe B, which is connected at one end with the purifying apparatus and at the other with the pipe L of the third portion of the apparatus or regulator.

It will be understood that the effect of the alternative action of the three bell chambers being constantly to suck up a body of gas equal to their capacity, and that on the other hand the production of the gas being necessarily variable, it is desirable, in order to maintain equilibrium in the aspirative action, to provide the necessary quantity of gas for that purpose. It will also be understood that it is necessary to be able to regulate at pleasure the amount of pressure or vacuum under the influence of which the gas is made to flow. For this purpose, if the distilling apparatus does not produce a quantity of gas corresponding to the capacity of the extractor, the bell chamber J of the regulating apparatus forces into the pipe B the necessary extra quantity of gas and returns it to the extractor Thus even if the production of the gas were to cease, the extractor would be continually supplied by the same gas circulating incessantly through the apparatus.

With regard to the degree of pressure under which the gas is desired to be produced, it may be regulated at pleasure by means of a counterweight. In order to obviate any inconvenience which might arise from the accidental stoppage of the extractor, two extractors are provided, one being always kept in reserve and attached to the pipes J, J, as shewn in the Drawing of the pyrotechnic apparatus.

Application of the Pyrotechnic Apparatus and of the Extractor.

In order to set an oven to work, it (as well as the heat reservoir) must first be raised to a high temperature by the application of heat, both to the interior and exterior; this being done, the fires in the fireplaces A, A, A, A, are to be kept up, and as soon as the coal has been introduced into the oven the doors must be closed, leaving, however, open for a few minutes the orifice of the extraction chimney G, to allow the aqueous vapours to escape, after which the orifice is closed by means of the cover L, and the hydraulic valve K, K, at the same time is opened to allow the gas to pass through the chimney G and the pipes J, J, which, as well as the interior of the oven, are protected from the pressure of the atmosphere by means of the communication then established between them and the exterior. The gas is thus aspirated or drawn by the extractor and forced into the various apparatus of which the gas works are composed. The extractor must be so regulated that its action shall prevent any variation of pressure on the pyrotechnic apparatus and its appendages.

When the coal submitted to distillation by the action of the heat in the fireplaces A, A, and in the heat chamber E, Q, Q, ceases to give off carburetted gas, the distillation is stopped. For this purpose the interior of the oven is

cut off from the action of the extractor by closing the hydraulic valve, and at the same time substituting the syphon pipe M for the cover L. The external air is then allowed to enter the orifices U, U, and the door F, F, in sufficient quantity to inflame a portion of the gases which are conducted through the passage N and channels O and C, C, together or separately, under the oven or ovens to which heat is required to be applied. This result is obtained by means of divers flues and registers, as shewn in the Drawings. When combustion of the non-carburetted gas has taken place, the apparatus must be hermetically closed, and after the lapse of sufficient time to allow the coke to acquire the consistency necessary for its discharge from the oven, that operation is effected in the ordinary manner and the coke treated at usual. Another charge of coal is then fed in and the operation proceeded with as before, the process of distillation being immediately commenced by the heat accumulated in the heat chamber E, Q, Q, aided by the furnaces A, A.

This heat chamber or reservoir, which is composed of incombustible materials, constitutes the principal distilling agent, and therefore constitutes one of the features of the present Invention; we attach also equal importance to the small furnaces below, and to the system of flues for conveying, as required, either the heat arising from the furnaces or from the carbonization.

We would here observe that the operation may be divided into four distinct processes, viz^{t}, first, the expulsion of the aqueous products through the chimney of extraction; second, the extraction of the carburetted gas by the distillation of the coal by means of the caloric accumulated in the flues and the surrounding mass of brickwork or masonry, and also of the small furnaces; third, the final carbonization of the coal by the combustion of a portion of the non-illuminating gases, which raises the whole apparatus to the degree of temperature necessary for effecting the distillation of a fresh charge of coal; and lastly, leaving the apparatus closed and in repose, in order that the coke may, while in a state of incandescence, acquire the solidity necessary for its discharge from the oven.

From what has been above stated, both with regard to the pyrotechnic apparatus and the extractor, it will be seen that they cannot be employed separately, as their combination forms the principal feature of the Invention, which has for its object the obtaining of hard coke, and also gas fit for illuminating purposes simultaneously, from the same charge of coal. When it is not desirable, however, to obtain the gas for illumination, it may be utilized in the manner above indicated for the non-carburetted gas; in this case the extractor not being necessary, the oven must, directly after the coal is fed in by means of the bent pipe M, be put in communication with the flues N, O, and C, the

gas or caloric being thus conducted under the bed of the ovens, as above described, for the purpose of heating them. In order to effect perfect combustion of the gases, a suitable quantity of air must be conveyed under the bed of the ovens. The draft chimney may be employed to draw off the gases from the interior of the ovens, instead of the extractor, and the extractor may be made to convey the whole of the gases under the bed of the ovens.

The Moderator.

The moderator is composed of the following parts, viz^{t}, first, a valve for regulating the flow of the gas; second, a float which gives motion to the mechanism by the action of the gas; third, a counterweight for regulating the degree of pressure under the influence of which the gas is made to flow; fourth, a metal casing enclosing the whole of these parts.

This apparatus is shewn in Sheets III. and IV. of the accompanying Drawings, Fig. 13 (Sheet III.) being an external elevation, Fig. 14 a plan view, Fig. 15 a horizontal section in the line C, D, of Fig. 13, and Fig. 16 a vertical section in the line A, B, of Fig. 14. The several figures in Sheet IV. represent various parts drawn on a larger scale. A, entrance pipe for the gas; B, exit pipe; C is a cover; D, a casing in which the valve H works; E, bell or floating chamber; F is a vibrating rod supporting at one end the bell chamber, by means of a chain G, and connected at the other by means of chains or rods to the valve H, by the valve rod I; J, J, is an atmospheric pipe furnished with a cock; P, K, is a vat or tank; L, a cross piece for supporting the beam F; M is a capacity occupied by gas; N, counterweight suspended from the rod O; Q, Q, is a circular chamber which passes round the bell chamber; and R is a pipe running up through the centre of the bell chamber; S, cheeks of the frame or casing D.

The valve H is composed of four parts; first, the wings, which are made by preference of a rectangular form and mounted loosely upon suitable bearings; secondly, the frame D (in which the wings work), made with two cheeks S, S, which are set in the pipe A and a portion of the space M. The wings in their movement are always in contact with the cheeks S. There are also two pieces, D^{1}, D^{1}, fixed above and beneath upon the framing D in opposite positions; a small hole is made in the lower one to allow the water of condensation to run off.

The "float apparatus" is composed of a tank K and a bell chamber E made of metal. The tank, which is also made of metal and is intended to receive the bell chamber E, is of a circular form, and is furnished on one side with a chamber for the reception of the counterweight N. The tank and its chamber

are both partly filled with water. To the tank are adapted the two pipes A and B, and the whole is surmounted by the cover C. The bell chamber E has a central pipe R running through it from top to bottom, and which serves as a sheath for the pipe J, J, which communicates with the atmosphere. At the top of the pipe R are small holes to allow of the escape of any air which might find its way between the water and the top of the bell chamber.

In order to prevent the too sudden action of the valve H the air can only find its way through these holes to or from the bell chamber E; this is the method we prefer, although the same effect might be obtained by diminishing the size of the orifice of the pipe J, J. This pipe branches off at its lower extremity into two parts, one of which rises to the surface of the ground and terminates in a cock A (Fig. 17, Sheet IV.), which, by communicating with the manometer B, allows the conditions under which the float apparatus is working to be ascertained. Under the boss of the cock A is an orifice C, through which the air necessary for the working of the apparatus circulates. A quantity of air equal to the capacity of the bell may also be introduced into it by means of the double valve bellows shewn at D (Fig. 18, Sheet IV.); the orifice being then closed by means of a screw plug the float will resist any pressure in the capacity M (Sheet III.), and the gas will then continue to circulate in the same manner as if the moderator did not exist, as by this means the action of the moderator upon the gas in the pipes is completely neutralized. The second branch J^1 of the pipe J remains underground; its office is to allow any water which might accumulate in the pipe J to run off; it terminates either in a syphon or a cock P (Fig. 16, Sheet III.) In the latter case, the cock is surmounted by a vertical pipe rising above the ground, having a suitable plug and handle by which the cock can be opened and closed. It is indispensable that this cock should be closed when the float is to be protected from the pressure of the gas by the introduction of air, as above mentioned. At each side of the cock A are two cocks E, F, (see Fig. 17, Sheet IV.) communicating with the main gas pipe by means of small pipes G and H, the pipe G being in front and the other H behind the moderator and in communication with the manometer, for the purpose of ascertaining the degree of pressure of the gas before and after entering the moderator. At the level of the pipes A, B, (Sheet III.) is a circular passage Q, Q, to allow of the passage of the gas when it is stopped by the rising of the bell chamber E. The counterweight N is composed of discs of metal mounted on the rod O, each disc being of such a weight as to counterbalance a certain amount of pressure. It is so arranged as that the counterweight shall act entirely below the lower level of the pipe A, and that on coming in contact

with the bottom of the chamber it shall prevent the further ascension of the bell chamber E. One arm of the beam F is connected to the bell chamber E and the other to the rod O of the counterweight by flexible steel rods or chains.

The outer casing (Fig. 13, Sheet III.) is composed of the above-mentioned parts, viz^{t}, the tank K, with its circular passage Q, Q, the casing D for the valve, and the cover C, which is of the necessary capacity to allow of the play of the beam F, and is furnished with projections outside to protect it from the pressure of the ground, and thus ensure the safety of the apparatus.

Application of the Moderator.

The pipe A is under the influence of an unregulated pressure. The valve H determines, according to its position, the size of the orifice through which the gas flows. The interior space M, behind the valve, contains the gas, the pressure of which is regulated, and which flows through the pipe B. The degree of pressure at which the gas is required to flow is regulated by the ascension of the float or bell chamber E, and this ascension is regulated by the action of the counterweight adapted to one arm of the beam F, the float or bell chamber E being in communication with the atmosphere by means of the pipe J.

In the position in which this apparatus is shewn in the Drawings the pressure of the gas contained in the space M, M, is supposed to be greater than the tendency of the float to rise. In this position the valve H will prevent the entrance of any more gas until the pressure of that contained in the space M diminishes. The float will then be allowed to rise, and the valve H opened to the required extent. If, on the contrary, the pressure increases, the float will be caused to descend, and by closing the valve H prevent the entrance of the gas. It is evident that by this means a uniform degree of pressure may be obtained, whatever may be the variations in the flow of the gas. The gas does not enter the bell chamber E, which is in communication with the atmosphere, but only acts upon its exterior. The gas in flowing does not undergo any change of direction, whatever may be the dimensions of the pipes which it traverses, and the moderator does not require to be made of large dimensions.

The waters of condensation which are found in the main pipes are not in any way prevented from flowing along the pipes. They even serve to supply the tank K (in which the bell chamber E works) with water. To conclude, the various parts of the apparatus cannot be deteriorated by the action of damp or air, as they are all saturated with gas.

The apparatus above described is more especially intended to be employed

underground, but it may, by means of the following modifications, be made susceptible of a more general application, and be made to act with greater precision in hotels, theatres, and other establishments which are lighted by gas, both for the purpose of protecting the burners from the variations of external pressure and also to prevent fraud in the consumption of the gas, by limiting the supply of gas to the burners by means of a regulating valve.

The first modification is shewn in Sheet V. of the accompanying Drawings, in which Fig. 20 represents a vertical section, and Fig. 21 a horizontal section. The difference between this apparatus and that above described consists, firstly, in setting the entrance and discharge pipes for the gas at different levels; secondly, the valve H, instead of being mounted horizontally in the induction pipe, as in the former instance, is in the form of a parabolic cone, and is mounted above and caused to rise and fall on a seat directly over the bell chamber or float; lastly, the counterweight N works in a chamber isolated from the tank containing the float. The same letters are marked upon corresponding parts as in the former arrangement, excepting that D represents the seat for the conical valve; H is the conical valve; I the chamber for the counterweight; and A^1 the space occupied by the gas which has not been regulated.

The second modification is shewn in Sheet VI. Fig. 22 is a longitudinal vertical section of the apparatus; Fig. 23 is a vertical section taken in the line G, H, of Fig. 22, and Fig. 24 is a similar section taken in the line C, D, of Fig. 22; Fig. 25 is a plan view, and Fig. 26 is a horizontal section taken in the line A, B, of Fig. 22. A spiral or other suitable spring is substituted for the balance beam and counterweight of the former apparatus shewn in Figures 20 and 21, Sheet V. *a* represents the entrance pipe, and *b* the exit pipe for the gas; *e* is the float or bell chamber; *f*, the spiral spring above the conical regulating valve *h*, which rises and falls on a valve seat *d*. The float or bell chamber works in a tank *k*; a pipe *j* for the entrance of air to the bell chamber *e* is furnished with a cock *p*; and a^1 is a chamber for receiving the gas before it is regulated; *m*, *m*, is a chamber into which the gas passes, and in which the pressure of the gas is regulated; *n* is a valve for regulating the exit of gas; and *o* an entrance cock. In this modification a fluid of great density, such as mercury, must be employed instead of water.

Having now described our Invention, and the best means with which we are acquainted for carrying the same into practical operation, we would observe in conclusion that we do not intend to confine ourselves rigidly to the precise details above given, as they may doubtless be varied without departing from the nature of our Invention; but that which we consider to be novel, and

therefore desire to secure under the herein-before in part recited Letters Patent, is,—

First, the pyrotechnic apparatus constructed upon the principle above described, and having one or more fireplaces or furnaces with a caloric reservoir or arrangement of parts for storing the heat, and also an arrangement of flues for the circulation and distribution of the caloric, the said apparatus having for its object the simultaneous production from coal of carburetted gas suitable for illumination, and of coke of suitable quality for the purposes of smelting metal and generating steam in locomotive engines, such operations being effected by the employment of the waste gases, or of all the gases if coke only is required to be produced.

Secondly, the application to the pyrotechnic apparatus of the extractor, its object being to protect the oven from the pressure of the gases of the atmosphere, and to draw off and collect the gas either for the purpose of illumination or to serve as fuel to the furnaces of the pyrotechnic apparatus, as above described and shewn in the Drawings.

Thirdly, the various forms of apparatus which we denominate the moderator, and which are employed for regulating the flow and distribution of the gas, as above described and shewn in the Drawings.

In witness whereof, we, the said Antoine Pauwels and Vincent Dubochet, have hereunto set our hands and seals, this Eighteenth day of October in the year of our Lord One thousand eight hundred and fifty.

ANTOINE (L.S.) PAUWELS.
VINCENT (L.S.) DUBOCHET.

Taken and acknowledged by Antoine Pauwels and Vincent Dubochet (parties hereto), at Paris, in the Republic of France, the Eighteenth day of October, One thousand eight hundred and fifty, before me,

Consul's Seal.

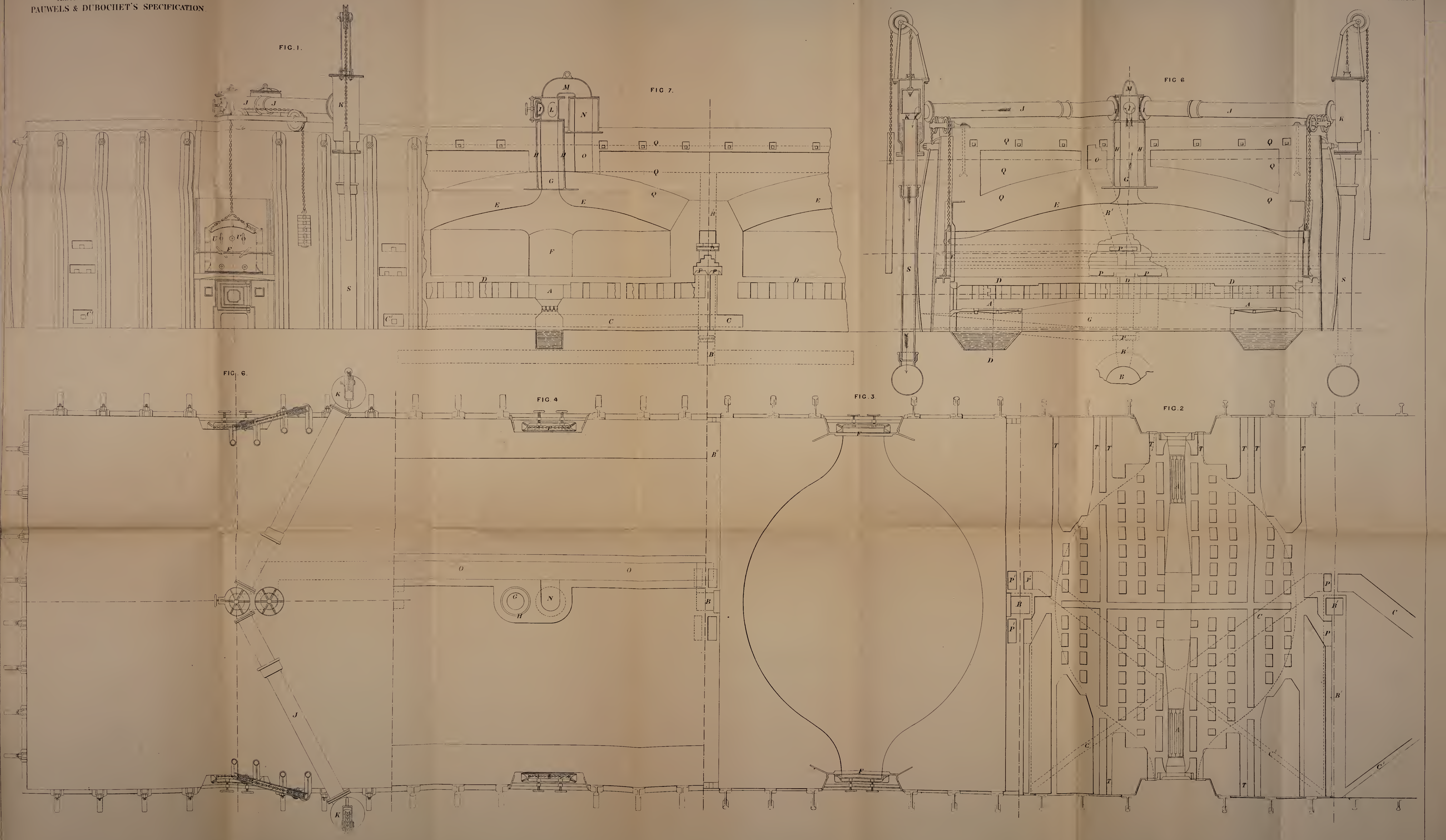
THOMAS PICKFORD,
Her Britannic Majesty's Consul at Paris.

Enrolled the Twenty-third day of October, in the year of our Lord One thousand eight hundred and fifty.

LONDON:
Printed by GEORGE EDWARD EYRE and WILLIAM SPOTTISWOODE,
Printers to the Queen's most Excellent Majesty. 1857.

A.D. 1850. April 25. Nº 13,057.
PAUWELS & DUBOCHET'S SPECIFICATION.

(6 SHEETS)
SHEET 1.



The enrolled drawing is partly colored

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FIG 12.

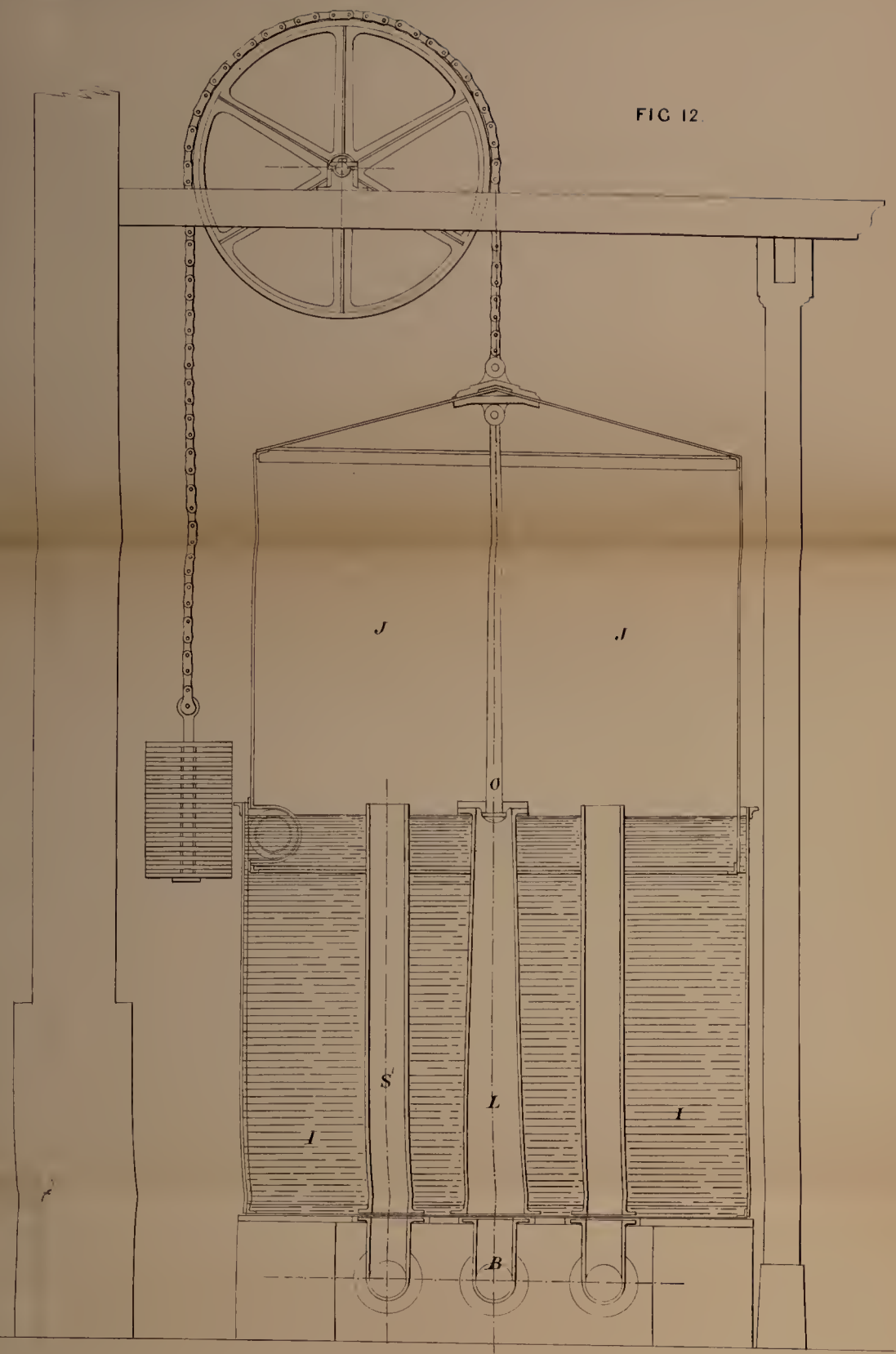


FIG 10.

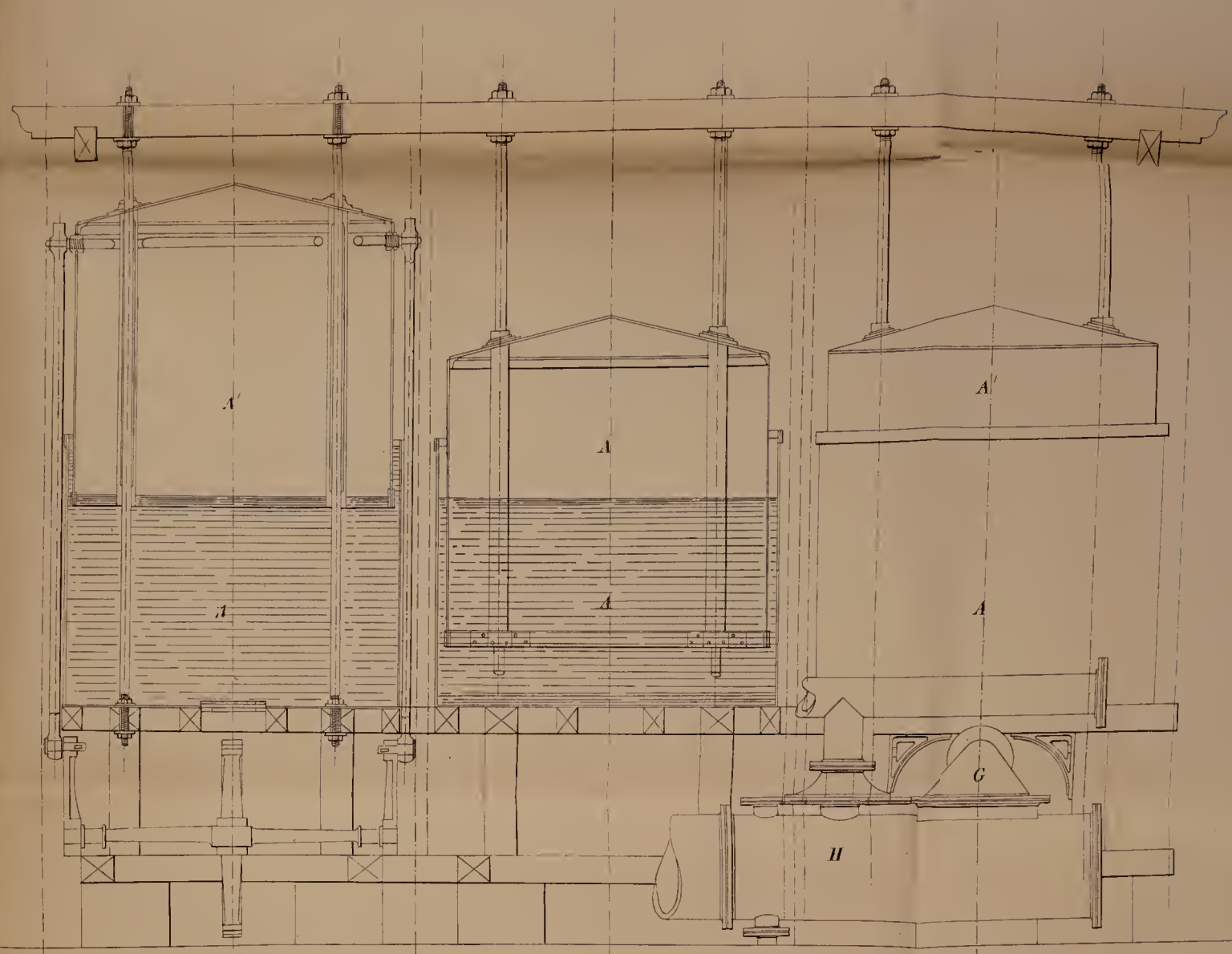


FIG. 16.

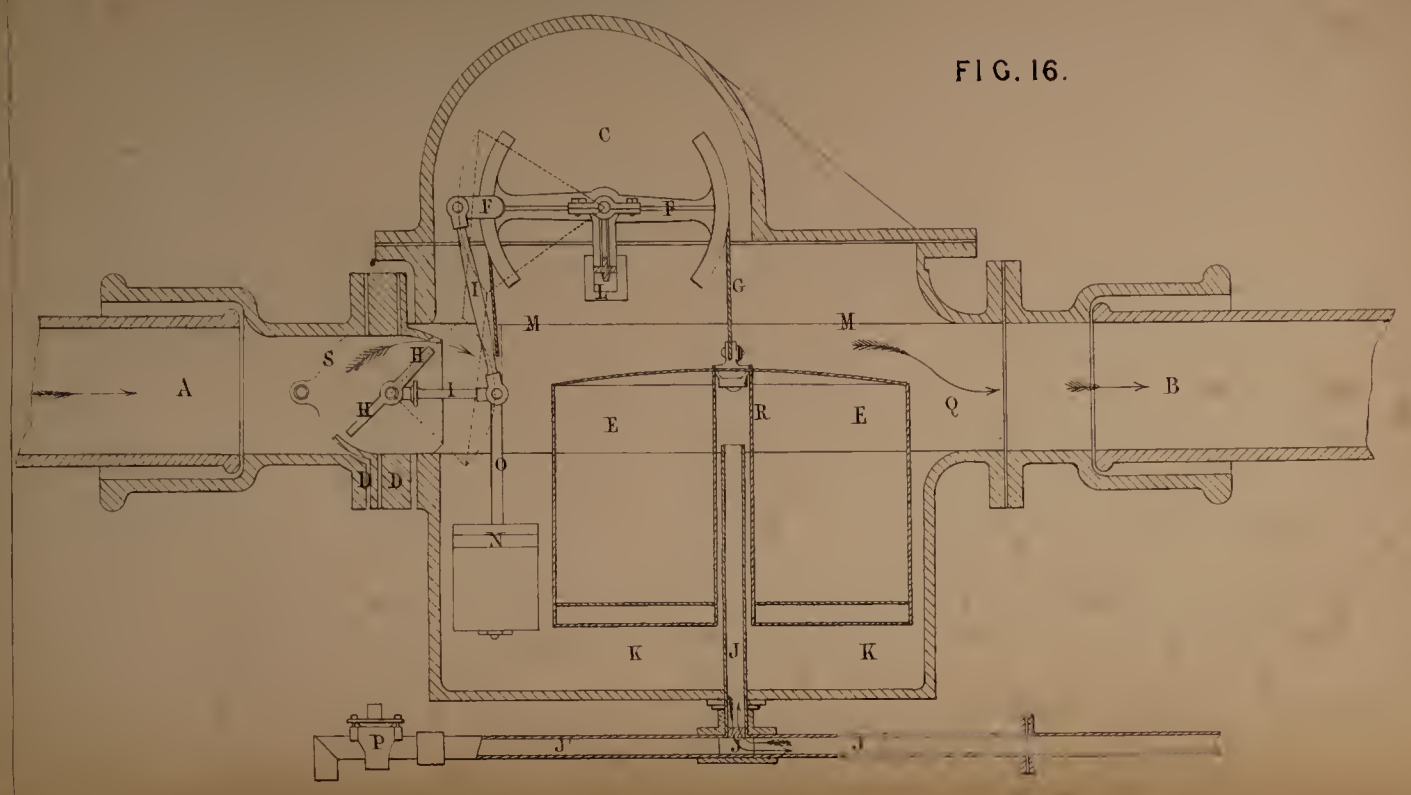


FIG. 15.

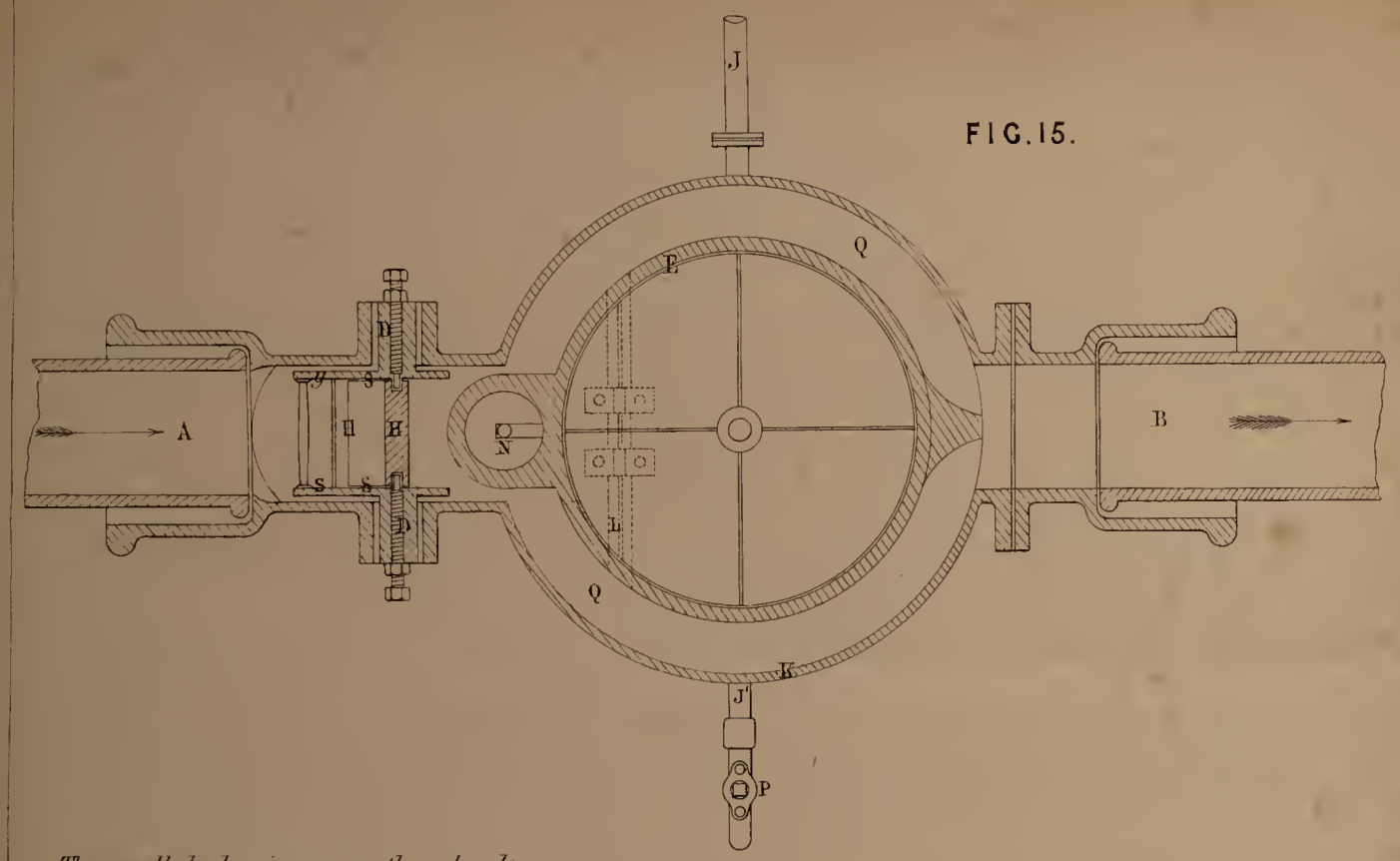


FIG. 13.

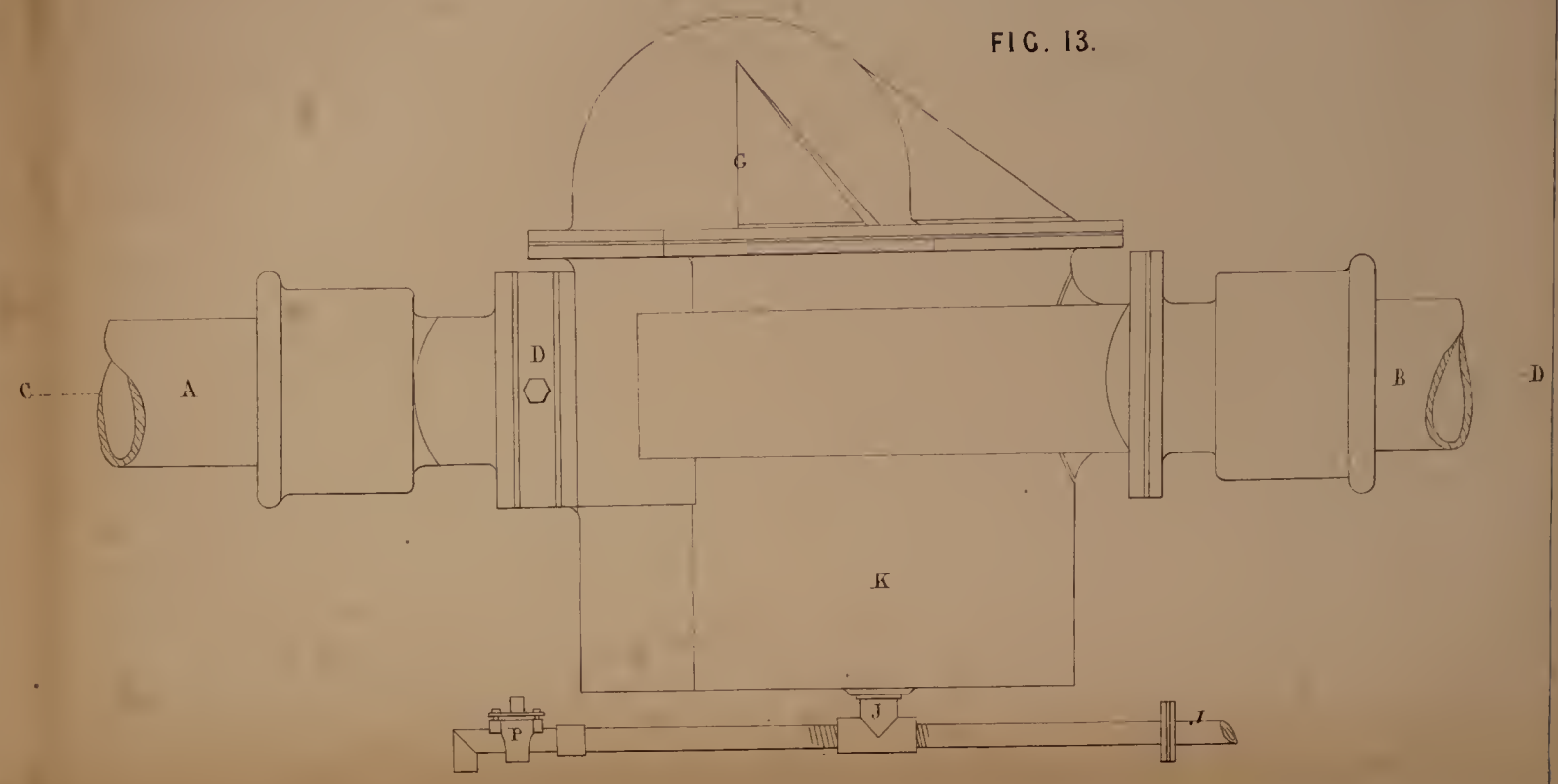
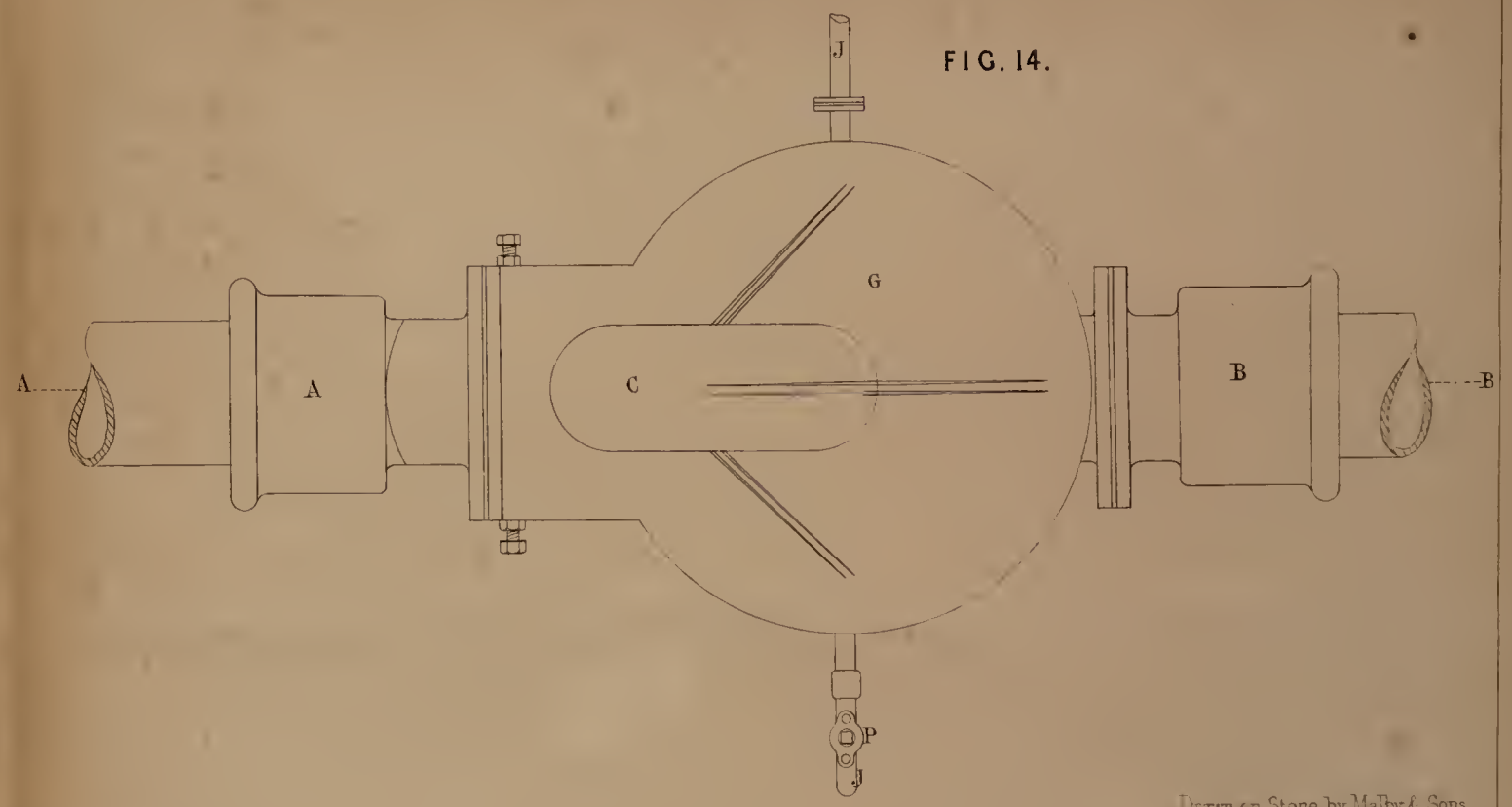


FIG. 14.



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Printers to the Queen's most Excellent Majesty. 1857

FIG. 17.

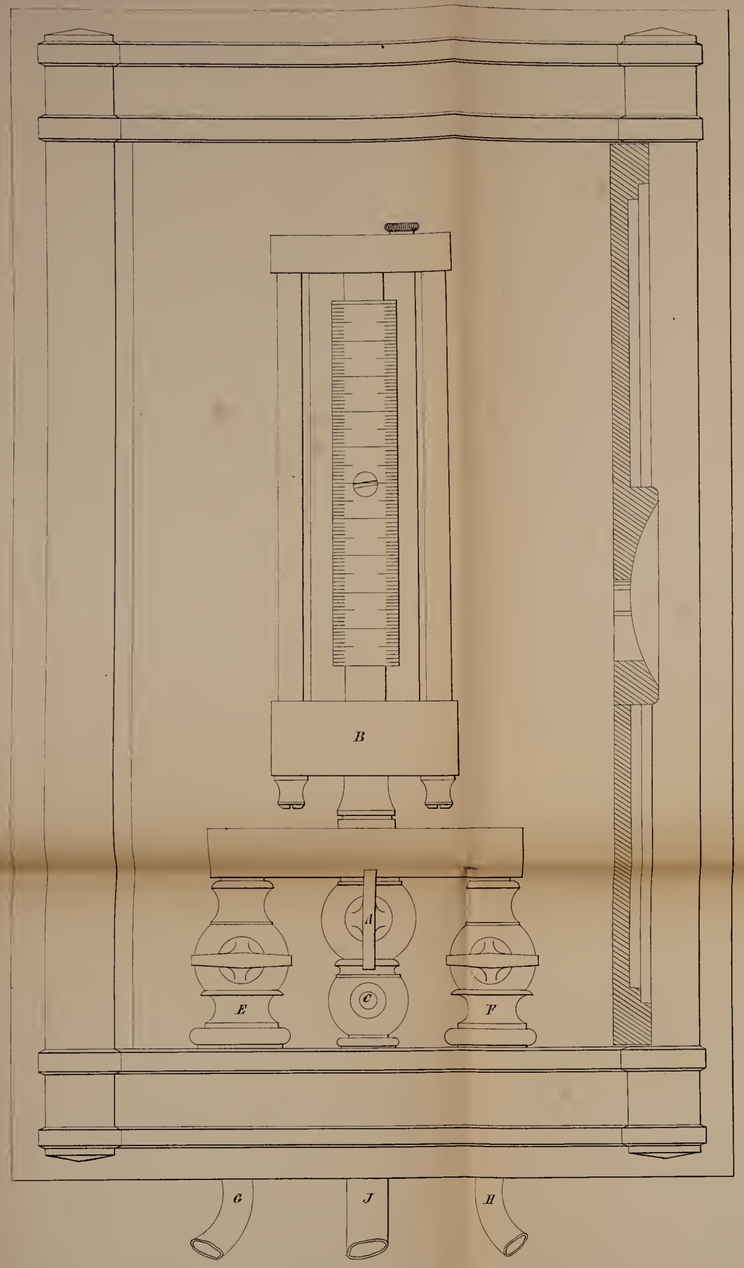
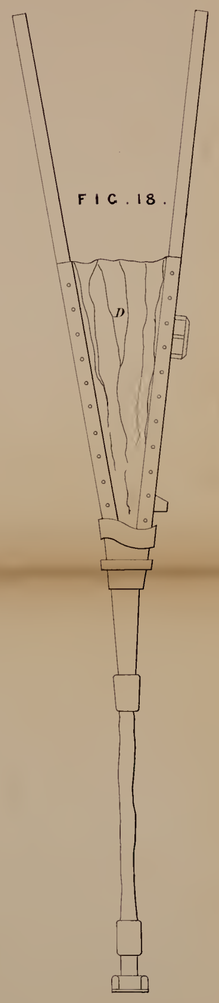
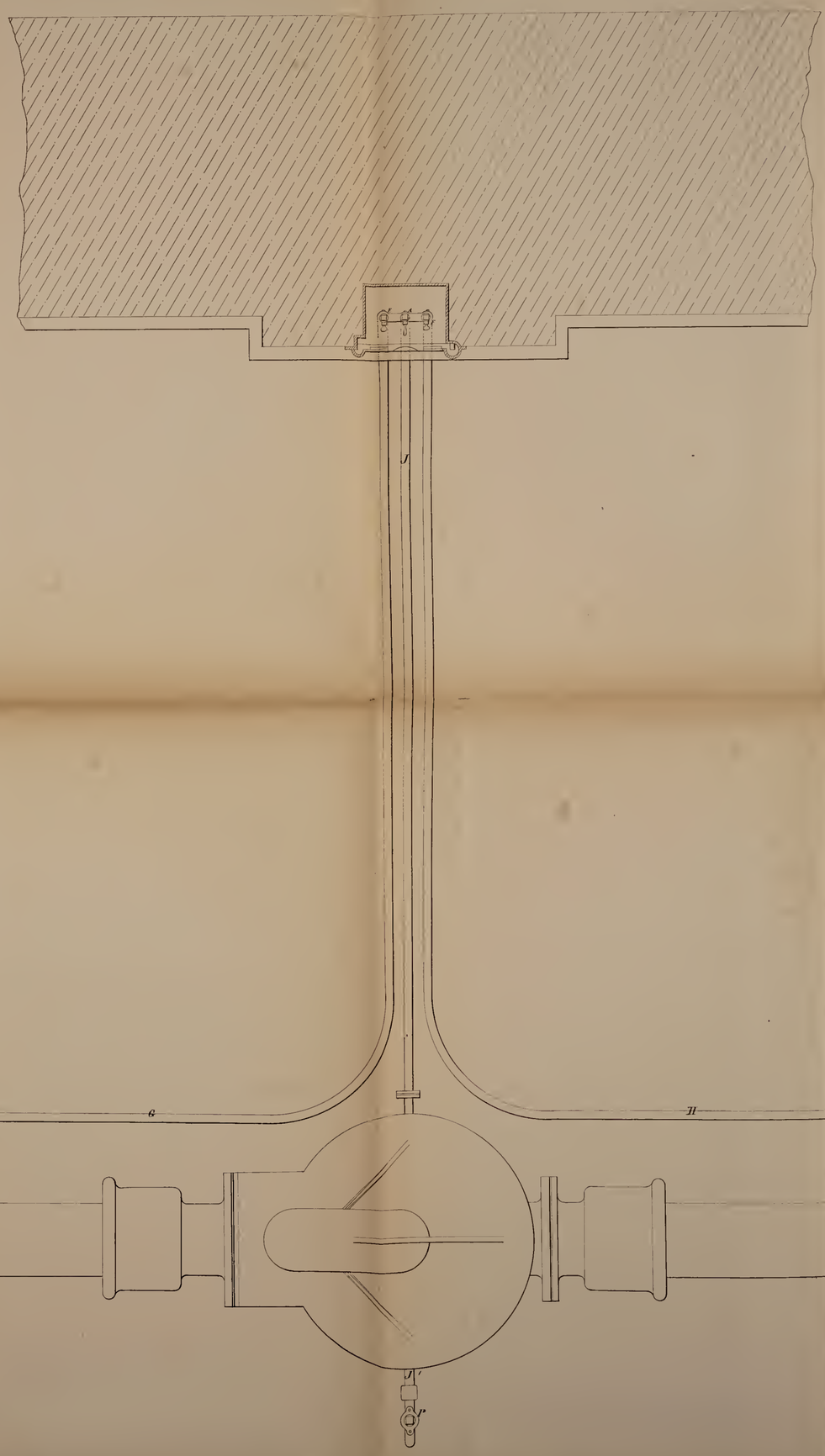


FIG. 18.





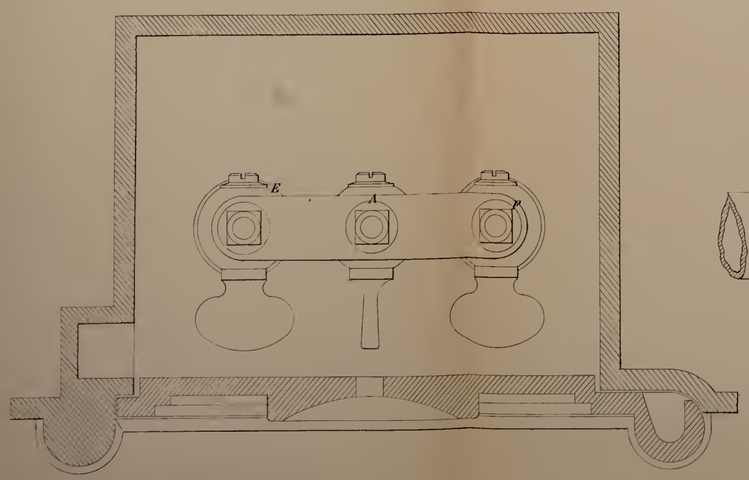


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FIG. 20.

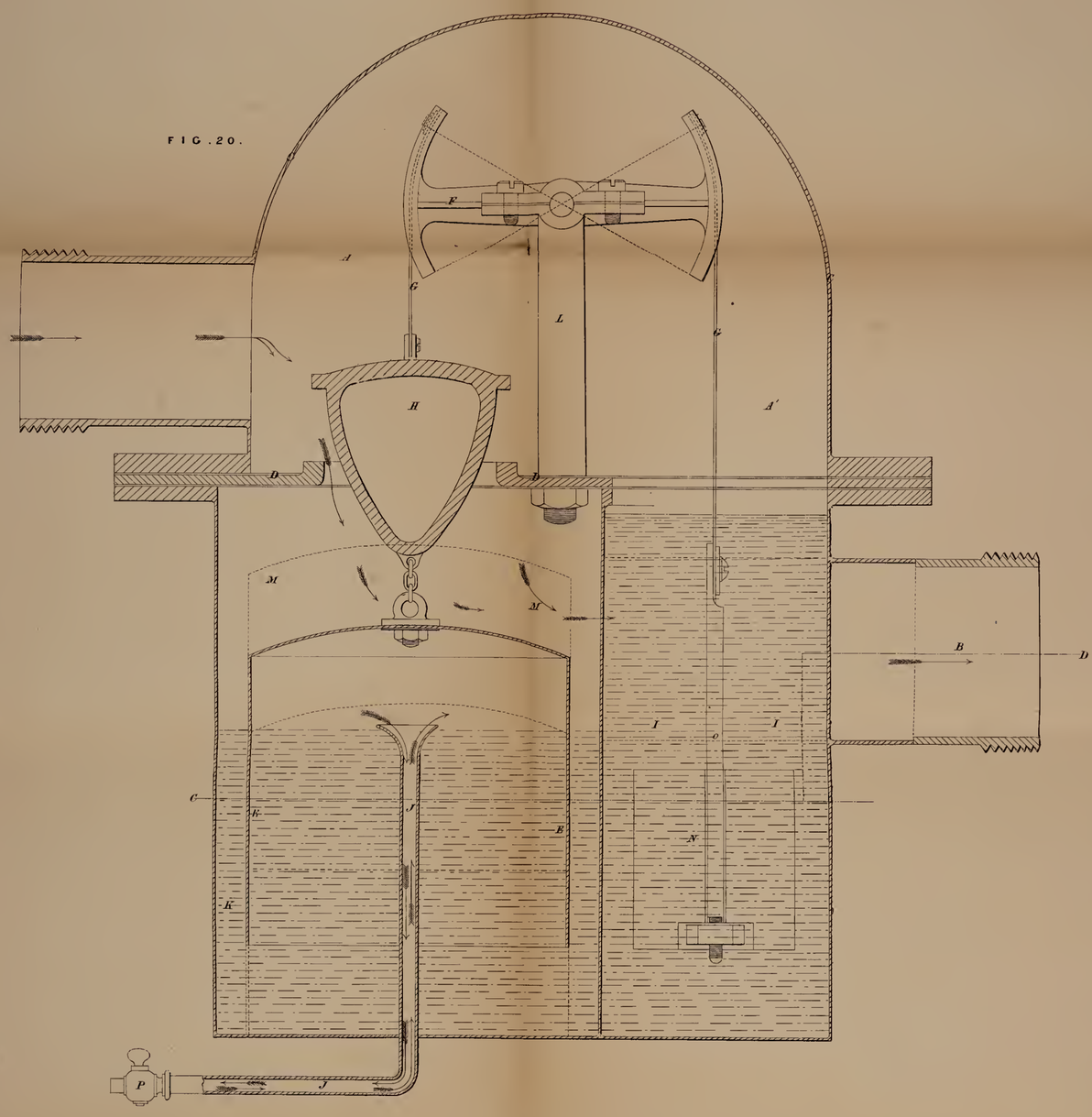
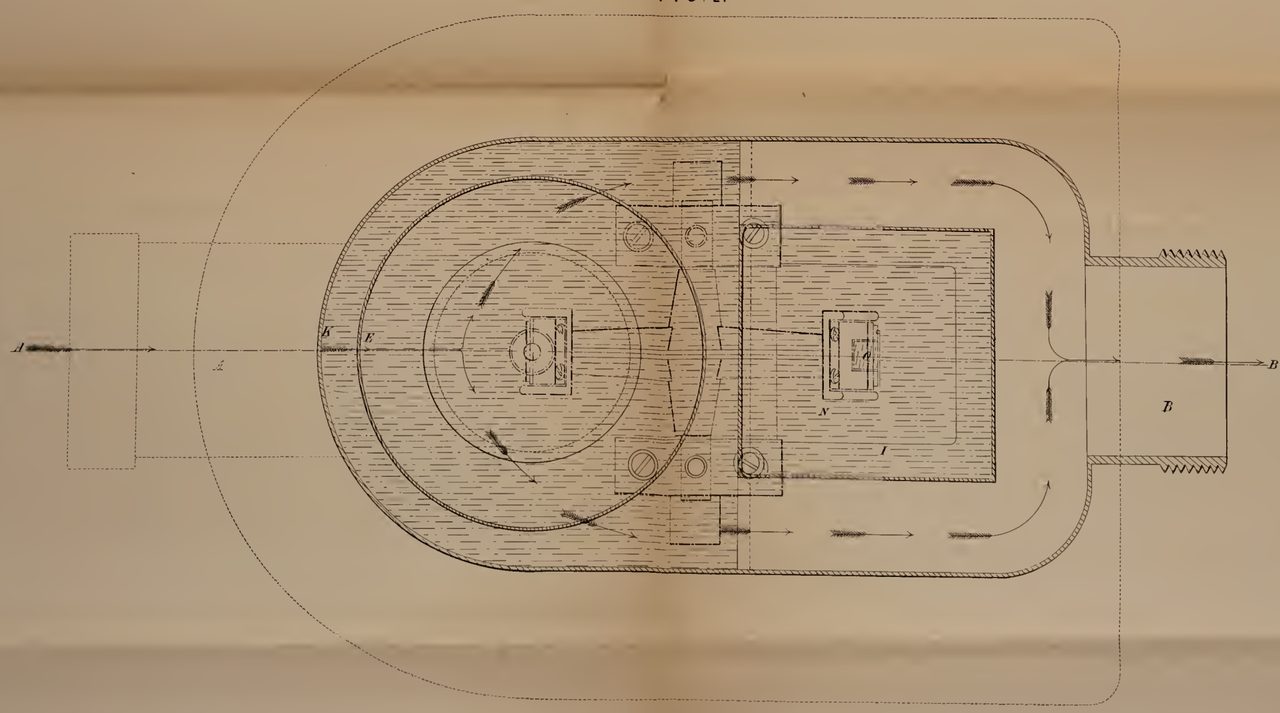


FIG. 21



The enrolled drawing is partly colored

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PAUWELS & DUBOCHET'S Specification.

(6 SHEETS)
SHEET 6.

FIG. 22.

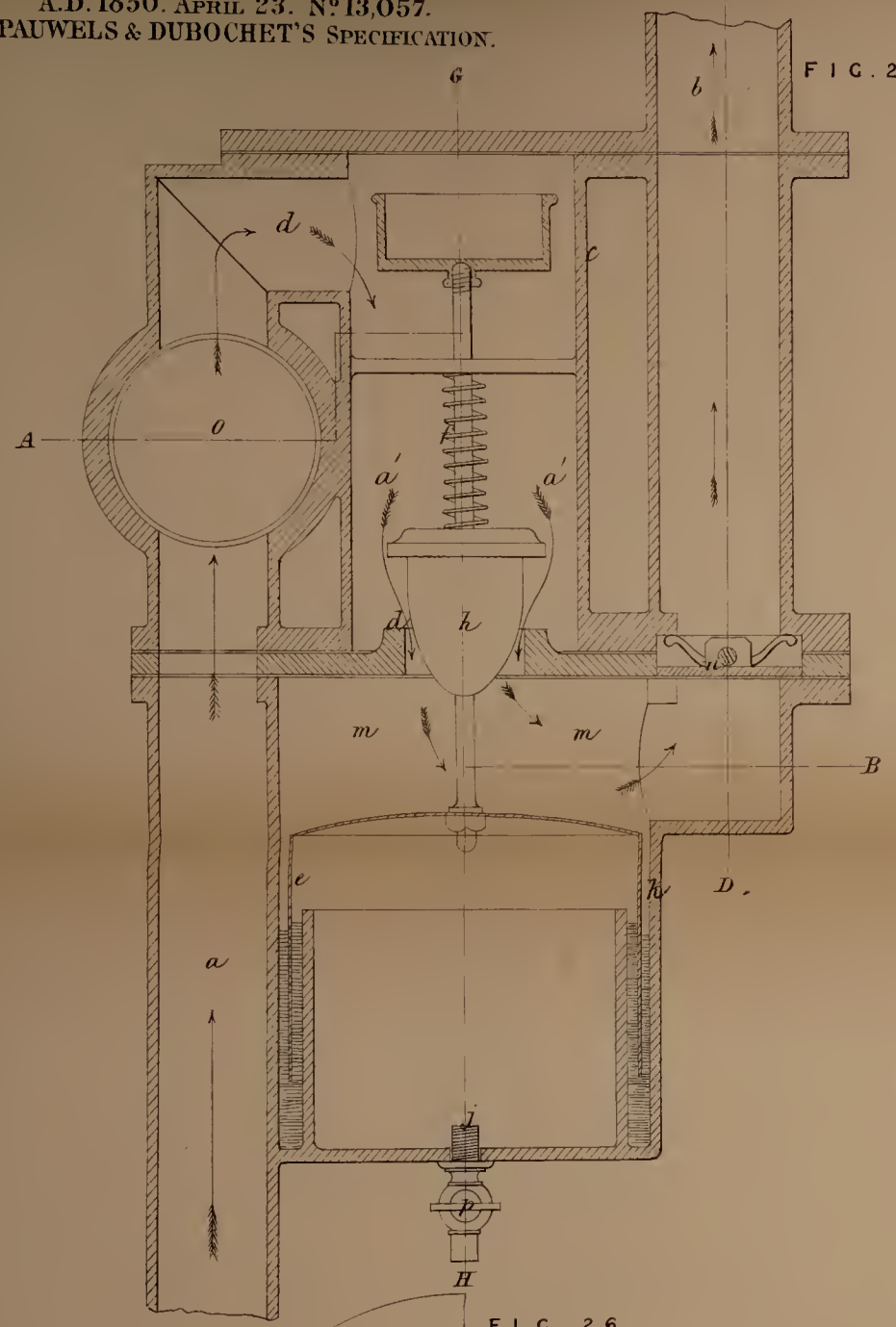


FIG. 23.

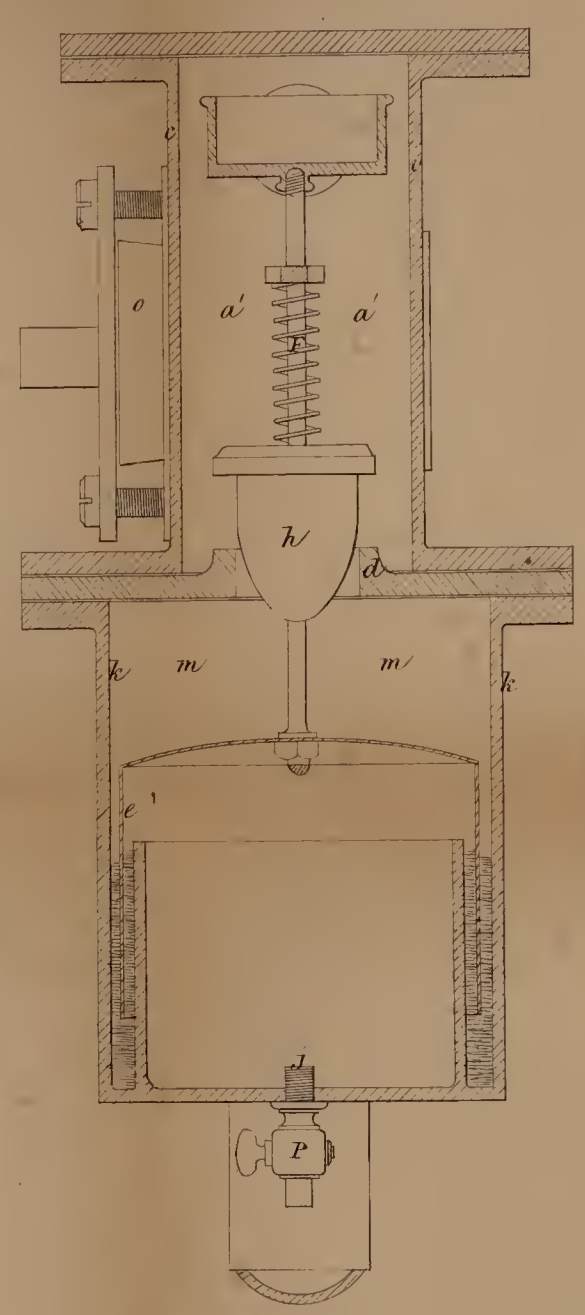


FIG. 24.

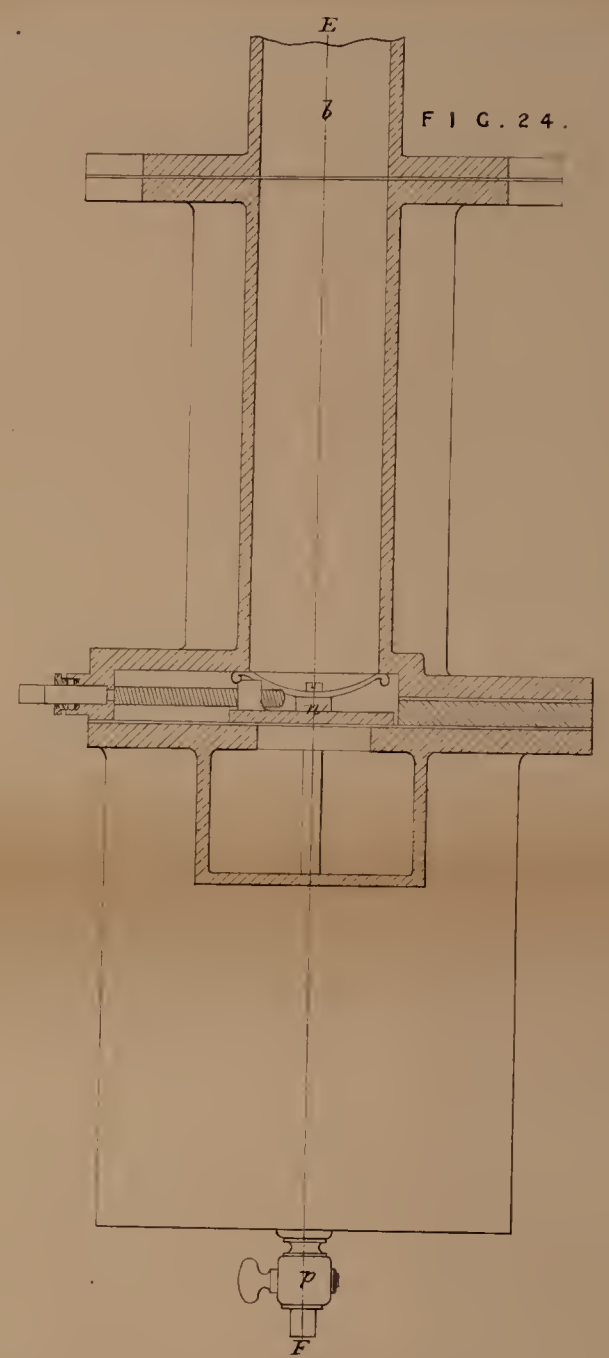


FIG. 26.

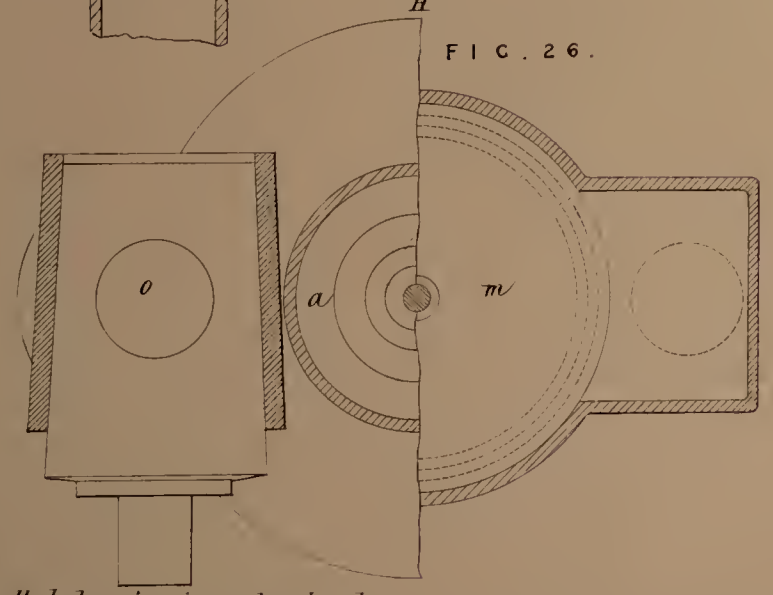
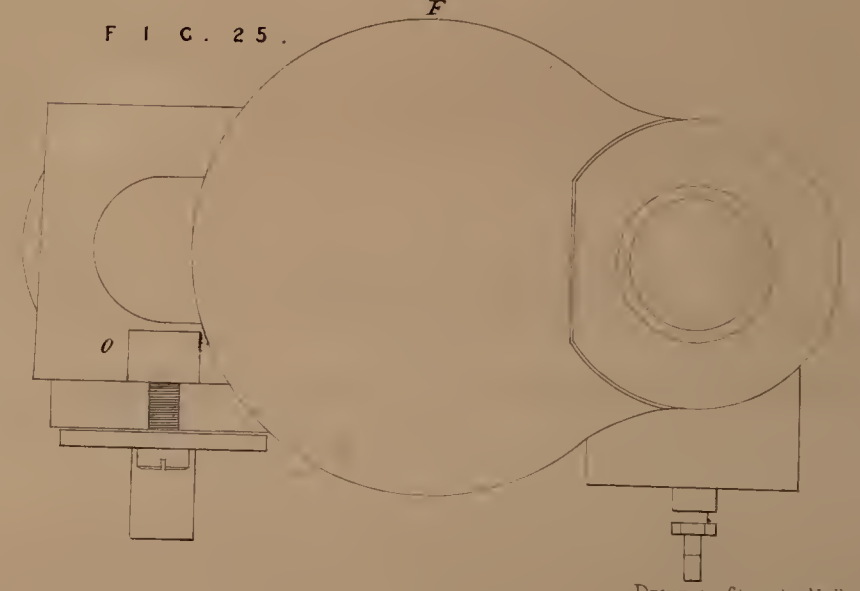


FIG. 25.



The enrolled drawing is partly colored.

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